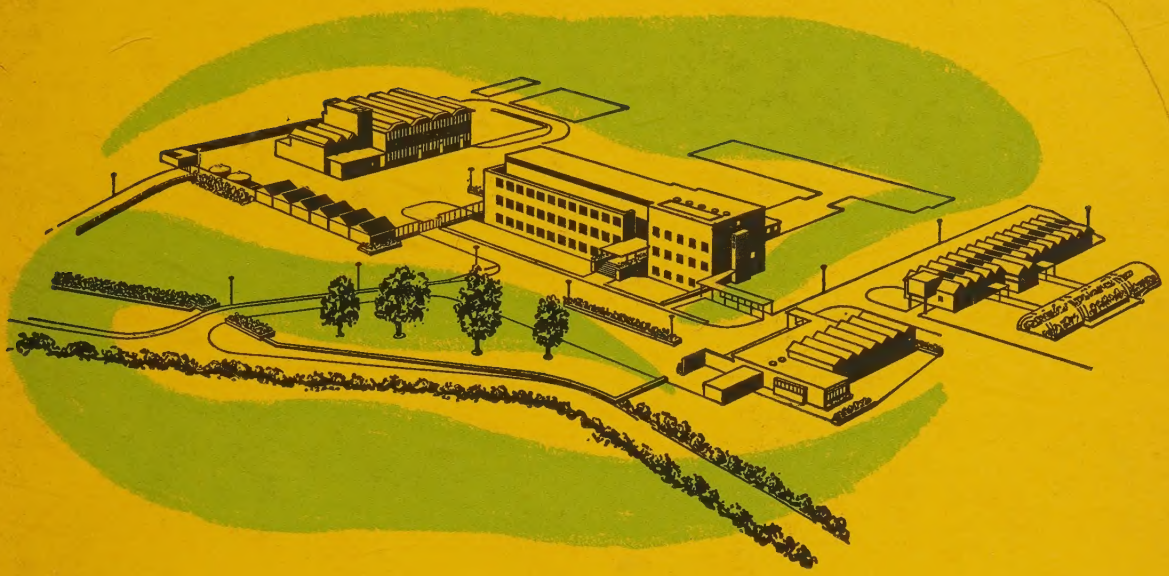

Levington Research Station

1959

COMMONWEALTH MYCOLOGICAL
4 MAY 1959

LEVINGTON
RESEARCH STATION
1959

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FISONS LIMITED

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J. M. Crewe, B.A.(Oxon.)
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Manufacturing Laboratory Section

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Chemical Engineering Section

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Senior Chemist — G. G. Brown, B.Sc.(Lond.)

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S. M. Janikowski, B.Sc.(Eng.)(Lond.)

Chemists — D. H. Booth, B.Sc.(Hull)
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Farm Manager (Levington)	J. T. Pemberton, B.A.(Cantab.)
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Field Experimental Officers	D. W. T. Brough, B.A.(Cantab.)
	H. R. Dally, N.D.H.
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	* * * *

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Statistician	* * * *

Analytical Section

Senior Soil Analyst	J. Hislop
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Soil Chemists	I. J. Cooke, B.Sc., Ph.D.(Leeds), A.R.I.C.
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	A. V. Flegmann, Dip.Agr.(Budapest)
	D. Gunary, B.Sc.(Nott.)
	D. J. Parton, B.Sc.(Wales)

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Plant Physiology Section

Senior Plant Physiologist	P. C. Owen, B.Sc.(Wales), Ph.D.(Lond.)

Biology Section

Senior Biologist	R. C. Stephen, B.Sc., Ph.D.(Aberdeen)
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	W. G. Masson, B.Sc.(B'ham)
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	W. A. White
	* * * * (2)

Laboratory Section

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ADMINISTRATION

Accountant-Secretary	C. Hancock, A.C.W.A.
Assistant Accountant	W. H. Fox, A.C.C.A.
Librarian	* * * *
Administrative Officer	D. W. Duke-Williams, M.A.(Cantab.)
Maintenance Superintendent	H. G. Horne

Seconded to Production Department as Project Manager:
K. A. Sherwin, B.Sc.(Eng.) (Lond.), D.I.C., A.M.I.Mech.E., M.I.Chem.E.

Appointments to be made in the development of the Station are indicated * * * *.

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LEVINGTON RESEARCH STATION was established by Fisons Limited to provide research of the highest standards into the use of their existing products and the development of new and improved fertilizers. The recommendations for the use of Fisons fertilizers depend upon the testing of products on the farms at Levington and North Wyke and in the many trials carried out all over Great Britain.

The research of the Fertilizer Division is centred on Levington which comprises the central laboratories with the associated farms and horticultural area. Supporting the Levington Research Station are the ancillary establishments of North Wyke Experimental Station in Devon for grassland research, and of Bramford Development Station near Ipswich for testing processes on the pilot-plant scale. The administrative staff at Levington provide the services at these sites including the accounting, library, instrument and engineering-workshop facilities which are necessary in a scientific research group requiring associated endeavours ranging from economic appraisals to the design of equipment. The scientific work of the Levington Station is divided between the Department of Soil Science and the Department of Chemistry. The former deals with soil and agronomic problems, seeking the greatest benefit from the combination of natural factors and the use of fertilizers. The fundamental studies and experimental investigations of materials in the Levington laboratories, pot trials and field experiments are supplemented by extensive trials throughout the country, controlled by the central staff and conducted by the officers of the Agriculture and Horticulture Sections on land of co-operating farmers and growers. The Department of Chemistry investigates new and improved processes for producing plant nutrients in forms which have suitable properties in manufacture, handling and use. Process developments are transferred for appraisal on the larger scale at the Bramford Development Station, where suitable control laboratories, workshops and more extensive Chemical Engineering facilities are available. This Station also studies plant operation and modification problems in collaboration with the manufacturing works of the Fertilizer Division.

The research stations are all of recent establishment and it is expected that the research groups will be expanded over the next few years, particularly at graduate level. The present complement includes about ninety graduates and two hundred and sixty non-graduate staff and wage-earners.

Department of Chemistry

Two main types of problem are studied in the Department:

(a) Complete and partial manufacturing processes on the bench and semi-technical scale.

(b) Supporting work on the properties of individual and mixtures of fertilizers which influence manufacturing procedures, handling and storage properties.

The Department is composed of two main Groups whose activities are largely defined by the division of the work according to the main two problems stated above. These Groups are the Basic Research Group and the Process Research Group.

Basic Research Group

This is divided into three Sections dealing with physico-chemical research and analytical problems.

Fundamental Research Section 1. Studies are in progress of the kinetics of absorption of gases, the drying characteristics of granular materials, and equilibrium properties of fertilizer/moisture systems.

Fundamental Research Section 2. Present studies include kinetic studies of some thermal reactions in mixed fertilizers, the diffraction of X-rays by inorganic salts, structural and availability studies of retarded nitrogen release fertilizers, and the thermal analysis of fertilizers.

Analytical Section. This Section is responsible for all chemical analytical work coming from the Departments of Soil Science and Chemistry dealing with fertilizers and with fertilizers with pesticides incorporated. The specific determination of pesticide concentration in the presence of fertilizer environment creates numerous analytical difficulties, but considerable progress has been made. A balance is maintained between routine analysis and development of new analytical methods.

Process Research Group

The process research group is divided into two sections, one of which is mainly concerned with laboratory scale research and the other with semi-technical scale work in the Process Laboratory.

Manufacturing Laboratory Section. Herein investigations are carried out aiming at the continued improvement of the range of fertilizers marketed. The work is done in close collaboration with the Production Department, the Soil Science Department and the Fundamental Research Group. Studies of portions of overall manufacturing processes are made with the particular objective of predicting large-scale behaviour. The assessment of storage characteristics forms an important part of the work and an excellent laboratory test method has been developed for this purpose.

Chemical Engineering Section. This is composed of a team of chemical engineers and chemists, the main duties are concerned with design and operation of semi-technical plant to investigate new and improved manufacturing processes: the Section is self-supporting for its analytical control work.

In both these sections, a number of fertilizers are prepared for field experiments and pot trials by the Soil Science Department.

Bramford Development Station

This Station is primarily a site for Chemical Engineering investigations, the main areas being pilot-plant buildings with associated chemical laboratories, offices and workshops. The graduate staff are supported by teams of process operators and engineering craftsmen, providing the abilities for designing, erecting and operating pilot plant and associated instrumental control systems.

The Station is concerned with improving present production processes in the factories by introducing new or modified techniques. The studies on relevant operations form an individual programme, which may well spring from the

Levington Research Station buildings consist of a laboratory and administration block, process laboratory, pot trials unit, canteen, garages and stores. Three hundred acres of farm land and a sixty-acre horticultural unit with glasshouses are attached.

Top: The Levington organization includes North Wyke Experimental Station near North Tawton in Devon for grassland research.

Left: Bramford Development Station provides facilities for chemical engineering studies.

Below: The Horticultural Unit of sixty acres is almost exclusively devoted to research on crops grown to commercial standards and to fine turf investigations.

knowledge and interests of the technical staff who have had experience in the factories. Similar types of problems may be raised by the technical staff of the Production Department. This work requires close collaboration with that Department, and also involves the Development Station staff in full-scale trials on producing units, and in providing commissioning teams for new processes. Throughout their work the staff maintain close collaboration with the Levington Chemistry Department, particularly in developments stemming from new processes and operations studied in that Department. The major studies thus range from the re-appraisal of hitherto established processes for the manufacture and handling of nutrient source materials to the investigation of novel procedures of chemical processes, physical operations and automatic control. Important subsidiary studies are concerned with specifying improved packages for horticultural and agricultural products.

Department of Soil Science

The Soil Science research programme is designed to advance knowledge of soil and agronomic problems especially in relation to fertilizer usage. The long-term study of fundamental principles is important, but many problems of more immediate concern are also considered. Laboratory studies, pot and field investigations are closely integrated.

Agriculture Section. At Levington the two farms occupy over three hundred acres. Most of this area is suitable for arable crop experimentation and the farming policy is designed to produce conditions favourable for this. On the remainder there is mixed farming with winter beef production and a Red Poll dairy herd. About seventy acres are used for demonstrating the effects of various rates of fertilizer treatment and estimating their profitability in both arable and mixed farming rotations. Grassland farming is the main study at North Wyke Experimental Station in Devon, which differs greatly from

Levington in being a heavy-soil farm in a high rainfall area. An Ayrshire dairy herd is the basis of production. Sheep have been introduced on each farm. At both centres, the needs of research govern long-term cropping and livestock programmes and land utilization. An Agricultural Economist advises on various enterprises.

Ten officers comprise the provincial field and advisory services of the Levington organization. As the experimental results obtained at Levington and North Wyke require to be examined under the greatly differing soil and climatic conditions found throughout the country, each officer supervises annually in his area about eight hundred plots mainly in statistically designed experiments. The officers are also available to supply specialist advice to farmers.

Grassland Research Section. This Section is located at North Wyke in Devon, and is specifically charged with research on the production and utilization of grass especially in relation to fertilizer usage. In addition to replicated plot experiments in which grass production is measured by harvesting and weighing, experiments utilizing grazing animals are being started. Fertilizer responses in grass under pasture management will be measured and pasture quality differences examined in terms of milk production or liveweight gain. The requirements of the grassland research programme will largely determine the farm policy at North Wyke. The section is also responsible for co-ordinating the grassland experimental programme at Levington and in the provinces.

The errors associated with short-period grazing experiments with dairy cows have been examined in two projects during 1958. In one of these, five groups of three cows were grazed on three different swards for periods of one week with changes of grazing to accord with a Latin Square design. The errors were small, and even with these short grazing periods it was possible to show that one of the three swards was significantly inferior to the other two, a difference between means of just over one gallon of milk per cow per week being sufficient for significance at the 1 per cent level. In the other experiment a similar design was employed to compare (a) lax grazing providing approximately 30 lb. dry matter per day without supplementary feed (b) restricted grazing supplying approximately 20 lb. dry matter per day without supplementary feed

(c) restricted grazing as in (b) plus a supplement of 5 lb. hay per day. No significant effect on milk production was found although the errors were low and a difference between means of less than one gallon of milk per cow per week was needed for significance at the 1 per cent level. These results indicate that a considerable wastage of grass may occur when cows yielding about three gallons per day are allowed to consume about 30 lb. of herbage dry matter daily.

A simulated grazing experiment comparing herbage productivity under sheep grazing with that under gang mowing or cutting and feeding indoors with return of dung and urine to the plots was commenced in June 1958 and will continue in 1959, as any differences are expected to be cumulative and should become more apparent as the experiment progresses.

Investigation of 2,4,5-T to eliminate clovers for experimental purposes was carried out and will continue. A grass establishment experiment showed that up to 30 lb. N and 50 lb. K_2O applied in the seedbed were without significant effect but that establishment was promoted when 25 lb. or 50 lb. P_2O_5 were applied. The application of 25 lb. P_2O_5 increased the growth of grass by 16 per cent whilst 50 lb. P_2O_5 gave an increase of almost 24 per cent.

Horticulture Section. At Levington, nine glasshouses constructed and operated according to normal commercial practice and covering half an acre are planted with tomatoes, cucumbers and carnations. Heating of the houses is by a high-speed hot water system using $1\frac{1}{4}$-inch pipes. House temperatures are thermostatically controlled. The second-year programme of research projects has been satisfactorily completed. Tomatoes cropped at the rate of 70 tons per acre, and cucumbers at 217 tons. The yield of tomatoes for the year was slightly less than that obtained during the first year of cropping, but this reduction was typical of that experienced throughout the glasshouse industry and was probably seasonal. The majority of treatments already laid down will be continued for some years, and are of considerable importance for comparing treatment effects on crop yields in following years. The marketing of carnations began at the end of July 1957, and by the end of 1958 a satisfactory yield of 31 blooms per plant was obtained.

Twenty-eight acres of apples and pears are grown on the delayed open-centre method. The rainfall experienced throughout the summer has resulted in the production of highly satisfactory growth and tree formation. The first crop was taken from the five acres of blackcurrants. The total yield was 13½ tons, this being a high yield for a first crop. The two acres of strawberries showed promise of an exceptionally heavy crop, but continuous rain during the fruiting period caused severe losses, and only 1 ton 3 cwt was marketed from the two acres.

About one acre of vegetables are grown annually, and there are four acres of fine turf. An extensive range of crops has been grown to determine the value of gibberellic acid, and a two-acre unit planted with trees, shrubs and plants provide facilities for research on products sold in the amateur market.

All crops are produced entirely for research purposes in which the section collaborates with the Field Experimental staff, thus ensuring that experimentally valid results are related to crops produced to commercial standards. Most of the top fruit area will not be under experiment until the trees are fully established. Fine turf investigations are proceeding on a wide variety of subjects.

The section has a complement of eight, comprising a horticultural research officer, a turf specialist, and horticultural advisers who are stationed at Levington and in the provinces.

Field Experiment Section. The agricultural and horticultural experiments at Levington and North Wyke are the responsibility of the Section which also collaborates with the Agriculture Section in managing those sited in East Anglia and the South West. Details of all provincial experiments are organized by the central staff, who also investigate field techniques and machines designed to improve the reliability of experimental results. Pot experiments are carried out in the glasshouses and covered cage of the Pot Trials Unit and a service is also provided in this way to other Sections of the Department.

Statistics Section. Field and pot trials are designed and a computing service for the statistical reduction and analysis of data is provided. Experimental techniques are investigated statistically and advice is given on problems of a more general mathematical nature.

Analytical Section. Soil and crop samples are taken through routine analysis at a rate of 60,000 samples annually. Of these samples 31,000 form part of the advisory service to farmers and growers, the remainder being derived from research investigations. Considerable attention is being devoted to the application of mechanization and automation techniques to facilitate these analyses.

Soil Chemistry Section. The existing knowledge of the fundamental aspects of the soil-plant phosphorus relationship is at a relatively elementary stage and, in view of its importance, the subject has been selected as the main problem for examination. The complexity of the subject requires investigation to proceed on several related topics, results eventually being integrated to give a more complete and balanced understanding of the whole concept. The methods in use or being developed in the Section are the measurement of labile soil phosphorus (the L-value) which is essentially a soil phosphorus capacity factor, soil phosphate potential which constitutes the soil phosphorus intensity factor, the kinetics of soil phosphate exchange reactions, total soil phosphorus by wet digestion techniques, and acid-soluble soil phosphorus by radiochemical methods. To twenty-three British soils, 500 lb. and 1,000 lb. water-soluble P_2O_5 per acre were applied in 1957, and it is intended to follow the fate of this phosphorus on the above lines. The L-values of these soils have been determined for two successive seasons and although it is too early to draw any definite conclusions, the average figures indicate that a large proportion of the applied phosphate has remained in a labile form in most of the soils. Radiochemical techniques have been developed in connection with this study for use on an extensive scale, and 2,000 samples per month were subject to radioassay.

The Section also studies other nutrients, for example nitrogen in the form of nitrogenous fertilizers and their chemical reactions in soil.

Pot trial studies including technique are continuing. Sub-irrigation of pots by standing them in wet sand provides adequate water for normal growth – a useful technique, provided that its limitations are recognized. An experiment using a modified Jenny technique to examine nitrogen, phosphate and potash status of eleven soils has shown that lettuce was significantly responsive to

nitrogen in six of the soils and to phosphate in six of the soils, but not responsive to potash in any of the soils. Lettuce is a highly variable indicator crop and extensive replication is necessary to detect small differences in nutrient uptake. Ryegrass and other crops providing a large number of plants per pot are more suitable.

Biochemistry Section. Electrodialysis of plant extracts in non-aqueous solvents has been used in the first stages of the investigation of the nature of organic phosphorus compounds in the plant and in the soil. The electrodialysis cell and techniques have been developed in co-operation with the Low Temperature Research Station, Cambridge. An automatic chromatogram scanner has been in use for a short time.

It is expected to use electrodialysis in conjunction with the automatic chromatogram scanner in an investigation of the relationship between the exudates from plant roots and the solubilization of soil phosphorus compounds.

Plant Physiology Section. The work of the Section is mainly concerned with the effects of mineral nutrition and water relations on the net assimilation rates and yields of vegetative and cereal crops. Particular attention will be given to the effects of nutrient/water interactions on the timing of physiological stages of agronomic importance.

Biology Section. The Section is mainly concerned with problems associated with the relationship between plants and soil micro-organisms and between host nutrition and disease incidence.

The results of two seasons experiments indicated that decreases in potato blight disease on the foliage are associated with increase in rate of nitrogen and potash application. Other data suggest that this may be related to the effects of plant nutrient application on plant development. The effect of nutrient application to the soil on plant growth and chemical composition is to be studied more closely.

Preliminary results from winter wheat field experiments show that whilst phosphate and potash applications to the seed bed have no effect on the

incidence of take-all disease, increase in the rate of applied nitrogen considerably reduced stand losses. The effect of rate and time of nitrogen application on take-all incidence is to be investigated further.

The Levington Farms

The two research farms at Levington occupy three hundred and thirty acres which would formerly have been described as typical 'sheep and barley' land. This is descriptive of the glacial soil on the plateau between the Deben and Orwell estuaries and it is predominantly light loam overlying sand and gravel. Left to natural vegetation it returns to gorse and silver birch scrub. A part of one farm is a valley leading to the Orwell estuary and in it the soils vary considerably and are less suited to field experimentation.

The annual rainfall must rank as one of the lowest in the country, the average for 1958 and the mean for the last four years being respectively 27·05 and 23·00 inches, with spring droughts much in evidence.

Early Development and Farm Buildings

Fisons Limited purchased Walk Farm and Red House Farm in October, 1953. During 1954 and 1955, many changes were carried out; rabbit-infested banks between fields were bulldozed out, superfluous fences removed and scrub eliminated. In addition, hedgerows and five shelter belts were planted, and at Red House Farm all fields were refenced. Some eight hundred tons of clinker were brought on to the farm to make hard standings for the farm buildings and farm roads. At Walk Farm, where the only buildings were two open cattle yards and a tithebarn, three new buildings were erected to give tractor, implement and workshop accommodation, a fertilizer store, grain drying and storage facilities, and covered cattle yards for winter beef production. In 1956

a further building was completed at Red House Farm, comprising a milking parlour and dairy, two covered yards with feeding passage, implement shed and dutch barn storage, all under one roof. Early in 1957 a range of old buildings at this farm was reconstructed to make loose boxes, calf pens, a meal barn and an open yard. There are walled pit silos at both farms.

Farm Planning

During 1954 and 1955, uniform cropping at low fertilizer rates was carried out to find existing fertility levels in order that the most uniform areas might be chosen for experiments.

Areas which have been selected for these special field experiments, in which nutrient comparisons are essential, do not have phosphate or potash applied until a deficiency occurs. Until then only nitrogen is used.

The land which is unsuitable for field experiments is used for commercial crop production.

After 1956, when the results of these first two years had been evaluated, cropping at Walk Farm assumed a more definite pattern, and certain areas were marked out for future use as demonstrational areas, as sites for annual experiments to be laid down on a rotational basis, and as sites for long term experiments.

Agricultural Demonstrations at Walk Farm

The object of the two agricultural demonstrations is to record the optimum crop response to compound fertilizer under Levington conditions and to examine costs in relation to yield, residual values receiving consideration. It will be some years before the records from these recently established, unreplicated trials can give a reasonably reliable picture of the position. The demonstrations occupy seventy acres which allow approximately four acres for each crop break in one demonstration and three in the other. Each of the three fertilizer treatments for each crop occupies about one acre while, as the result of the cross-treatments of fertilizer, residual areas from the previous cropping year, are about one-third of an acre.

The percentage composition of the compound fertilizers used in 1958 in these rotations is as follows:

	N	P_2O_5	K_2O
Fisons 31	9	9	15
Fisons 32	12	9	9
Fisons 35	5	12½	12½
Fisons 37	—	16	16
Fisons 39	9	6	18
Fisons 41	10	10	18

Six-course Cash Crop Demonstration. This was started in 1956 on area 14, the rotation being: Potatoes, Peas, Wheat, Sugarbeet, Oats and Barley. In all cases three different levels of fertilizer have been applied for each crop. In the cases of peas and cereals, these levels increase from north-west to south-east and in the root crops from south-west to north-east; the applications on the root breaks therefore cross the applications on the straw break.

Levels of fertilizer application have been:

Potatoes (1956, 1957)	8, 14, 20 cwt/acre 31 plus Aldrin
Potatoes (1958)	8, 14, 20 cwt/acre 41 plus Aldrin
Peas	1½, 3, 4½ cwt/acre 37
Wheat (spring) 1956	1½, 3, 4½ cwt/acre 39
Wheat (winter) 1957, 1958	1½, 3, 4½ cwt/acre 35 plus Aldrin
Sugarbeet (1956, 1957)	8, 11, 14 cwt/acre 32
Sugarbeet (1958)	8, 11, 14 cwt/acre 39
Oats	1½, 3, 4½ cwt/acre 39
Barley	1½, 3, 4½ cwt/acre 39

During 1959 the area will get the following uniform nitrogenous treatments for the assessment of phosphate and potash residual effects:

	Sulphate of ammonia Rate
Potatoes	6 cwt
Peas	Nil
Wheat	4 cwt
Sugarbeet	5 cwt
Oats	3 cwt
Barley	3 cwt

Twelve-course Mixed Farming Demonstration. This twelve-course system will come into full rotation in 1962 as follows:

> 3 years Timothy/Meadow Fescue/clover ley, Wheat, Sugarbeet. Barley (undersown), 3 years Cocksfoot/lucerne ley, Kale, Barley, Barley (undersown).

From experience on the farm it is expected that the cocksfoot/lucerne mixture will be more manageable and more profitable than a pure stand of lucerne which suffers from the weed Agrostis gigantea.

The principle of using three levels of fertilizer appropriate to each crop, as outlined in the six-course cash crop rotation, is embodied in this design and will be fully operative from 1960 onwards. The following cropping programme for 1959 develops the rotation and gives the fertilizer rates in ascending order:

F. Kale	4, 8, 12 cwt 41 0, 2, 4 cwt S/A	M. Barley	2, 3½, 5 cwt 32
E. Barley	2, 3½, 5 cwt 32	L. Sugarbeet	5, 9, 13 cwt 39
D. Barley (undersown)	1, 2½, 4 cwt 47 1, 1, 1 cwt S/A	K. Barley (undersown)	1, 2½, 4 cwt 47 1, 1, 1 cwt S/A
C. 1st year ley grass/clover	0. 1½, 3 cwt 47 0, 1½, 3 cwt S/A	J. 1st year ley lucerne	2, 4, 6 cwt 47
B. 2nd year ley grass-clover	nitrogen only	H. 2nd year ley lucerne	none
A. 3rd year ley grass-clover	nitrogen only	G. 3rd year ley lucerne	none

It will be evident that these demonstration rotations can be regarded as small, independent farms from which comparisons of relative profitability of the respective enterprises can be secured over a long period. The mixed farming rotation at three levels of fertilizer, which introduces both sheep and store cattle, will present many problems of management to secure maximum utilization of herbage grazing and conservation as well as livestock consumption of arable crop by-products and residues.

Manurial Reference Trials. These small-scale plots in area 14 are related to the rotation demonstrations. The trials were started in 1956 to demonstrate crop growth differences between balanced and unbalanced fertilizer treatments.

All crops receive the following treatments, the rate of application used being appropriate to each crop:

1. No fertilizer
2. Nitrogen only
3. Phosphate only
4. Potash only
5. Nitrogen and phosphate
6. Nitrogen and potash
7. Phosphate and potash
8. Nitrogen, phosphate and potash
9. Nitrogen, phosphate and potash and farmyard manure
10. Farmyard manure only

Specialized Field Experiment Area

Nutrient Response Rotation. A block of over fifty acres at the north of the farm (area 11) is designated for specialized fertilizer experiments of the type in which definite nutrient responses are essential for critical comparison, and a six-course rotation has been designed to produce conditions which will meet these requirements. This rotation has been adopted only because of the particular experimental conditions which are required. The basic cropping programme is:

Crop	Fertilizer	Remarks
A. Clover	Nil	Experimental area 1957
B. Barley undersown	Nitrogen only	Experimental area 1958
C_1 & C_2. Experimental area 1959	Experimental fertilizers	—
D. Potatoes	Nil	Experimental area 1960
E. Sugarbeet	Nitrogen only	Experimental area 1961
F. Winter wheat	Farmyard manure only	Experimental area 1962

In the year preceding the experiments the crop gets no fertilizer. In other years only nitrogen is applied until either phosphate or potash deficiency appears in the crops, except that to maintain a suitable soil structure approximately 15 tons of farmyard manure from the bullock yards is applied to the clover stubble preparatory to sowing winter wheat. When a nutrient deficiency

occurs small applications of the deficient nutrient will be given to ensure continued withdrawal of the residue of other nutrients. This rotation will be changed if the results in the long-term experiments in area 12 indicate a better system.

The southern part of area 13 is also devoted to annual experiments but in this case there is a normal farming rotation. Long-term and rotational experiments are sited on the extreme south-east side of the farm (area 12); the whole of that area and some 12 acres at the northern end of field 15 is in reserve for similar purposes.

Livestock

Dairy Herd and Cropping at Red House Farm. A dairy herd of forty Red Polls was started in 1956 and is kept at Red House Farm. This is one hundred acres in extent and with the exception of one field (area 1N) commercial fertilizer levels are used. Twenty acres are in permanent pasture and eighteen acres of very light land are in lucerne. For the past two years the practice has been to take two or three silage cuts from the lucerne and to follow this with late grazing. In 1958 two silage cuts were made and a third cut was processed into cubes. The final stand was strip grazed. The remaining sixty acres are divided into seven approximately equal fields which are cropped for five years with a long-term ley followed first with kale and then early potatoes before sowing out again. The mixtures used for long-term leys have hitherto been the cocksfoot/clover type but in future it is intended to use meadow fescue/timothy/clover. Should a ley prove unsatisfactory during the course of its normal life, it will be ploughed up for a short-term Italian ryegrass ley to provide for a longer grazing season.

Of the forty Red Poll cows in the herd, twenty were originally purchased in 1956, ten as pedigree in-calf heifers and ten as non-pedigree cows. The remainder were added at subsequent times and were purchased either privately or at dispersal sales, £90 being the highest price given for any one cow. The aim is to produce milk as cheaply as possible from grass during an extended grazing season with winter-fed hay, silage and kale, using a balanced concentrate mixture to supplement these foods.

Eighteen of these cows averaged 9,400 lb. in their first lactation. A nine-hundred gallon average is the present aim. Heifer calves only are reared and the herd remains basically a one-man unit.

Sheep. Sheep were introduced into the farming policy in the autumn of 1958 when forty-five pedigree Suffolk ewe lambs were bought from two established East Anglian flocks. It is intended that the flock will increase to keep pace with the developing experimental programme and it is expected that store sheep will need to be bought in from time to time to consume the extra produce from the mixed farming demonstrations and the grassland experiments.

Winter Beef Production at Walk Farm. To provide farmyard manure for the farm, experimental requirements, and horticulture, it has been the policy to fatten store cattle in yards. During 1953/4 and 1954/5 this was done in open yards; from 1955 onwards the cattle have been housed in the new covered yards where straw is used liberally and from which some five hundred tons of farmyard manure are produced annually.

During 1956/7 and 1957/8 two lots of eighty Friesian steers were fattened each winter. This was expected to be more profitable than fattening one lot carried right through the winter, but owing to the high price of stores for the last two years and the narrow margin of profit, this was not the case.

During 1958/9 one lot of one hundred bullocks were fattened from October to March and were drafted out fat from the end of January onwards. During the first half of the fattening period the cattle were fed kale and sugarbeet tops and straw. Home-grown concentrates replaced the sugarbeet tops after Christmas.

Experiments on hormone implantation carried out in October/December 1957, in conjunction with the School of Agriculture, Cambridge, and the Fatstock Marketing Corporation, showed considerable financial benefit from implanting the cattle with Hexoestrol, provided the plane of nutrition was satisfactory. Bullocks are implanted half-way through the fattening period when concentrate feeding begins. All fattening cattle are weighed monthly to estimate the liveweight gains, and this information is supplied to the School of Agriculture, Cambridge, who are carrying out research on the rearing of beef steers, with particular reference to the Friesian breed. These records have also provided useful data for working out a feeding plan.

Results of Agronomic Experiments – 1957

Experiments in 1957 covered a wide field of subjects in Agriculture, Horticulture and Pot Trials. In the main, results are restricted to one year's experiments and accordingly the following general statements have limited value.

Results of experiments should be viewed in the light of the weather in 1957. Throughout the country, rainfall was much below average during spring, while the period from late June to September was exceptionally wet. On the more freely draining soils, crops tended to suffer from spring drought, and grassland production during this period was below average. Later in the season rainfall was adequate, and most crops yielded well. Virus yellows of sugarbeet and potato blight were more severe than usual and limited yield in cases where control measures were not effective. Cereal and potato harvesting conditions were bad in the wetter parts of the country.

Agricultural Results

With the particular set of conditions existing in the 1957 Season, no large differences were detected in fifteen experiments on barley, grass, sugarbeet and kale between response to ammonium nitrate, ammonium sulphate, nitro-chalk and urea. An experiment in East Anglia comparing a number of nitrogen sources on potatoes failed to demonstrate a differential loss of ammonia by volatilization but the test was probably not sensitive owing to a low nitrogen response. Prilled ammonium nitrate caused more scorch on two grass sites than other powdered and granular nitrogen sources at equivalent nitrogen rates but the degree of scorch on the worst plots was not important. Ammonium sulphate in solution applied to grass by spraying or trickling caused unacceptably severe scorch at two sites. The scorch caused by ammonium nitrate in solution was not severe and would be acceptable. Urea was the most suitable nitrogen source of the three tested for applying in this way.

In a series of nine experiments on typical barley soils, application of half or more of the nitrogen in June gave a markedly inferior yield of grain at some centres compared with earlier applications. Such losses more than offset the slightly superior feeding quality arising from small increases in crude protein content obtained.

At twelve centres examining autumn and spring applications of nitrogen to grass for spring growth, autumn applications although showing visible responses in the autumn did not give as good yields in the spring as spring applications. Of the spring times of application February generally gave the best yield at the first cut, whereas there was a residual effect from the March application apparent at the second cut, and at the first cut this later time also gave herbage with a higher crude protein content.

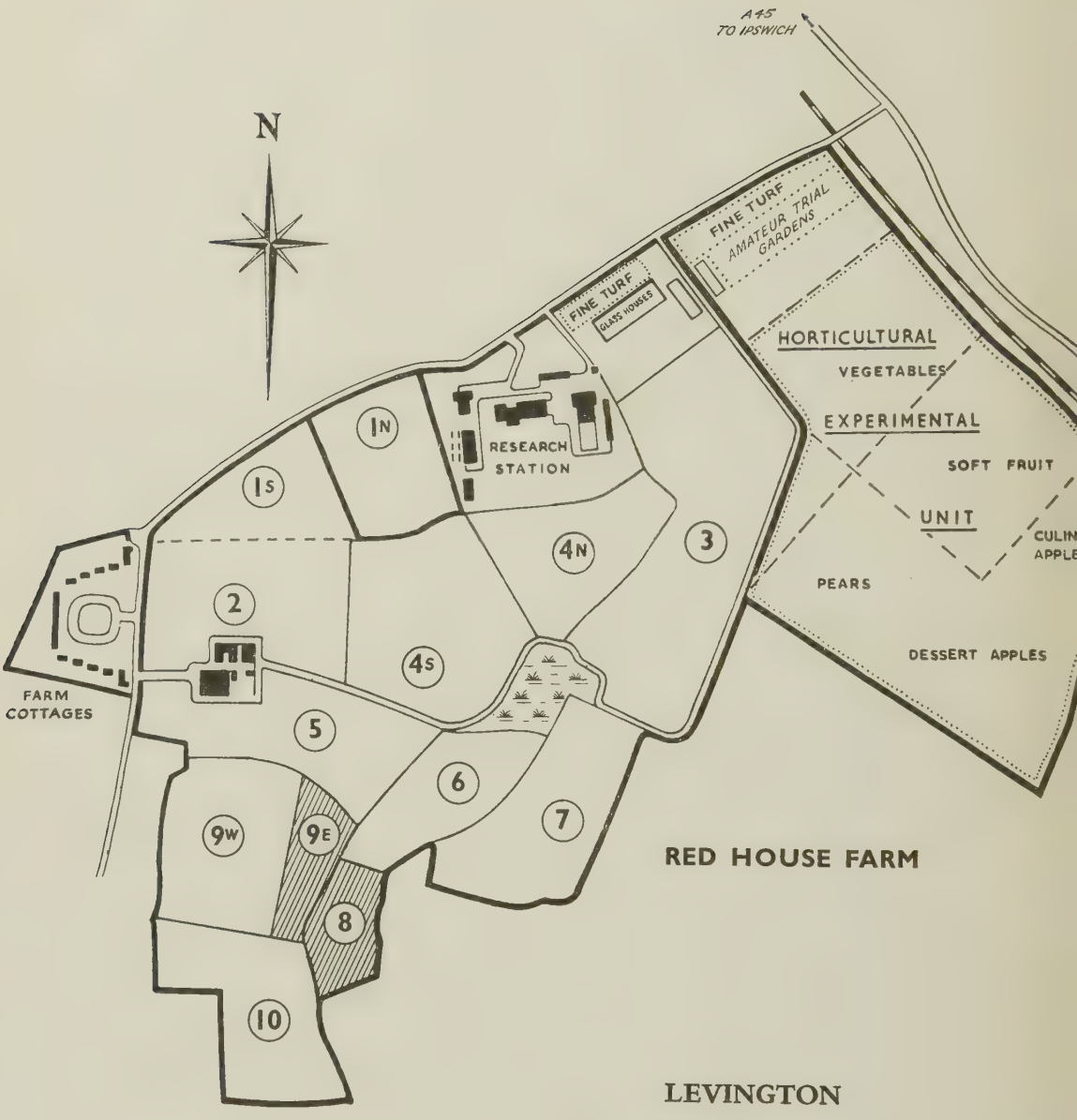
Phosphate top-dressing of swedes and oats gave responses which were reduced compared with seedbed application but worthwhile compared with no phosphate application.

Nine potato experiments on soils with pH ranging from 5·0 to 7·5 compared various nitrophosphates at differing water-soluble/water-insoluble phosphate ratios. Of these, six were phosphate responsive. In both acid and alkaline soils the magnitude of response fell with decreasing water solubility, 100 per cent water-insoluble phosphate having little effect in the season of application.

A series of annual experiments on typical soil types throughout the country examining four rates each of nitrogen, phosphate and potash in all combinations was continued with ten sites on potatoes and seven sites on swedes. On potatoes nitrogen increased the yield at eight centres, phosphate at five and potash at five. On swedes nitrogen increased the yield at three centres, phosphate at six and potash at four. In ten experiments on barley and spring wheat nitrogen increased yield of grain at four centres, phosphate at four and potash at two.

Five experiments examining the effect of fertilizer and magnesium applications on the chemical composition of grassland species, with reference to hypomagnesaemia were continued at Levington. Complete results from one of these confirm that applied magnesium at rates up to 45 lb. MgO per acre has little effect on herbage mineral composition. Nitrogen and potash can affect it markedly and when very high rates (240 lb. N and 200 lb. K_2O per acre) of these were applied together the herbage had a composition likely to lead to hypomagnesaemia.

Spray applications of iron, manganese, boron, copper, zinc and molybdenum to sugarbeet on two typical soils and to oats on three typical soils gave no indication of a beneficial effect.



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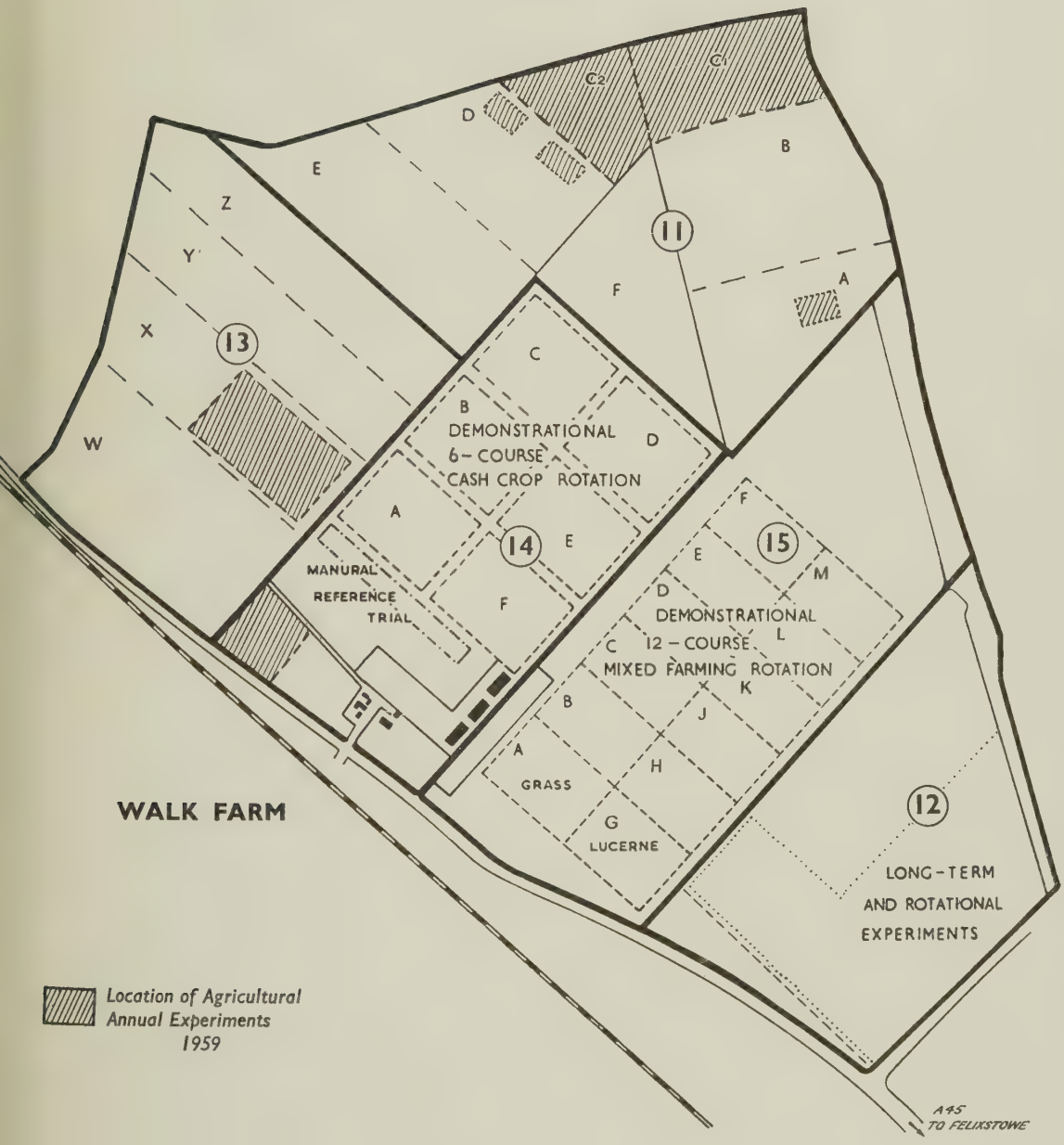
1959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DEMONSTRATIONAL
6 – COURSE
CASH CROP ROTATION
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12 – COURSE
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AND ROTATIONAL
EXPERIMENTS
WALK FARM
A45
TO FELIXSTOWE
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Aldrin incorporated in compound fertilizer for potatoes continued to give good control of wireworm attack without adversely affecting tuber quality, even when applied at high rates in two successive seasons. Tecane generally showed good control of wild oats as in 1956 but was less effective on soil of high organic matter status. The reasons for this are being investigated in further field and pot trials.

A series of experiments examining the use of M.C.P.A. in fertilizer carriers for the control of grassland weeds showed that creeping buttercup was more effectively controlled than bulbous buttercup or creeping thistle.

Maleic hydrazide applied to potatoes as foliar spray at 2·5 lb/acre between 23 July and 6 August reduced sprouting markedly. Tuber yield was not affected and maleic hydrazide content of the tuber did not exceed 22 p.p.m. Later applications had little effect on sprouting in this one experiment.

Horticultural Results

A long-term glasshouse experiment on tomatoes examined various rates and combinations of phosphate base dressing and nitrogen, phosphate and potash top dressings. In this first season soil reserves of phosphate appeared to be sufficient for the requirements of the crop and no increase in yield was obtained above the recommended rates of nitrogen and potash. No differences in yield or quality of tomatoes or cucumbers resulted when a number of organic and inorganic nitrogen sources were compared at equivalent nitrogen rates.

Various dilutions of fertilizer in solution were compared with solid feeding on tomatoes but results are so far inconclusive.

A heavy pre-planting dressing of farmyard manure produced a good first crop of strawberries and additional fertilizer appeared to have no further effect at this early stage. Differences are expected to show up in subsequent crops.

Chelated iron and magnesium were examined on tomatoes and a number of glasshouse flower varieties with particular reference to improvement of quality and the correction of chlorosis but, as in 1956, there was no evidence of a beneficial effect from these materials. The colour and vigour of the foliage of a

number of flowers and vegetables grown outdoors under alkaline soil conditions were not improved and in general the materials were toxic at the rates used.

Maleic hydrazide was applied as a foliar spray to lettuce and red beet with the object of inhibiting bolting. The maleic hydrazide did not prevent the formation of inflorescence, although inhibiting elongation, and market quality was severely impaired. Maleic hydrazide was also effective in controlling suckering in tobacco without scorching. However, severe chlorosis and a significant reduction in the length of the top two leaves occurred, these being indicative of quality and yield reduction. Maleic hydrazide successfully inhibited the growth of privet and hawthorn shoots without causing scorch or discoloration. Growth of fine turf was not satisfactorily inhibited without an unacceptable degree of scorch and discoloration.

A number of ureaformaldehydes were compared on fine turf with standard organic and inorganic nitrogen sources. In general the ureaformaldehydes released nitrogen more slowly than standard organic sources and high uneconomic nitrogen rates were needed to obtain comparable responses.

Fisons 18-15 gave good control of partially resistant turf weeds such as clover in one application. Two or more applications of other herbicides would normally have had to be given to obtain an equivalent result.

Certain metallic salts, such as copper dihydrazine sulphate, gave good control of turf mosses.

Pot Trial Results

The Pot Trials Unit was used extensively by the fundamental research sections and their results are commented on elsewhere. Experiments were also carried out to supplement field work on ureaformaldehydes, nitrophosphates and on numerous other subjects.

Two series of experiments examined the short- and long-term effects of various ureaformaldehyde formulations compared with standard organic and inorganic nitrogen sources. In the short term the ureaformaldehydes were generally found to be inferior to the standard inorganic sources but some of them were comparable to the standard organic sources. The long-term experiments are not yet finished.

In pot experiments on nitrophosphates, response to phosphate fell with decreasing water-solubility, thus confirming field work. In other experiments, it was found that anhydrous and dihydrate dicalcium phosphate produced similar responses, that the powdered forms were more effective than the granular, and that incorporation with the soil was more effective than placing in contact with the seed. These effects were the same for acid and alkaline soils, broadcast powdered dicalcium phosphate giving responses equivalent to those of triple superphosphate.

There was no advantage from coating red beet, turnip and carrot seeds with small quantities of nitrogenous or phosphatic fertilizers.

Mercurial seed dressings containing up to 4 per cent mercury had no detrimental effects on germinating oat and sugarbeet seeds although the germination of oats was delayed slightly.

Field and Pot Experiments - 1959

Field and pot experiments, an essential part of the fundamental and applied studies, link laboratory investigations with farm and horticultural practice. The research farms, the horticultural unit, and the provincial advisory service throughout the United Kingdom are available for carrying out experiments. In this way, research projects organized from Levington can be examined in all phases of the soils and climate which constitute British farming and horticulture. This season more than sixteen thousand plots in agricultural and horticultural experiments are being laid down, over half being provincial, and the Pot Trials Unit at Levington has an extensive supplementary programme.

Agricultural Field Experiments

The 1959 agricultural programme consists of 461 experiments comprising 13,082 plots. Subjects of investigation which are continuing from 1957 and 1958 include (a) sources of nitrogen for grassland and arable crops, (b) nitrophosphates, (c) phosphate and potash requirements of crops when high nitrogen levels are used, (d) time of nitrogen application for barley, (e) time of phosphate

and potash top dressings for established lucerne, (f) time of application and types of basic slag for grassland, (g) granule size of compound fertilizers, (h) magnesium for arable crop production, (i) the effects on composition of spring grass of small annual applications of magnesium compounds, (j) improvement of marginal grassland by application of lime, slag and trace elements, (k) fertilizers incorporating insecticides for the control of wireworm and wheat bulb fly and incorporating herbicides for weed control, (l) plant nutrition in relation to the incidence of potato blight and cereal take-all, (m) field experimental technique. New studies include (n) effect of phosphate on cereal development, (o) time of application of phosphate and potash to grassland and wheat, (p) effect of combine drilling high rates of nitrogen and potash with cereals.

At Levington this year annual and long-term experiments occupy about thirty-two acres; here the crops under investigation include grass, autumn and spring cereals, potatoes, sugarbeet, swedes, mustard, kale, lucerne, clover and Russian comfrey.

Key to Locations

L	Levington Research Station, Ipswich, Suffolk
W	North Wyke Experimental Station, North Tawton, Devon
E	East Anglian counties
1	Aberdeen and North-East Scotland
2	Edinburgh and South-East Scotland
3	Carlisle and North of England and South-West Scotland
5	Chester and West Midlands, North Wales and Lancashire
6	York and Yorkshire
7	Lincoln and East Midlands
8	Bristol and surrounding counties
9	South-Western counties
11	Guildford and South-Eastern counties

Code No.	Title	Crop	Subject under investigation	Location
1.1/1	N source and time	Winter wheat	Nitrogenous fertilizer for autumn application	L, 5
1.1/2	N source, top dressing	Winter wheat	Nitrogenous fertilizers as spring top dressing	3, 5, 8, 9, 11
1.1/3	N source, seedbed	Barley	Nitrogenous fertilizers for seedbed application	6, 7, 8, 11

Code No.	Title	Crop	Subject under investigation	Locations
1.1/4	N source and time	Grass	Time of application in relation to spring growth	E, 6, 7, 9
1.1/5	N source, seedbed	Sugarbeet	Nitrogenous fertilizers for seedbed application	E, 6, 7, 8
1.1/7	N rate and time	Grass	Autumn and spring applications in relation to spring growth	1
1.1/8	N rate and time	Barley	Time of application in relation to yield and quality of grain	L
1.1/9	N source, calcareous soils	Grass	Various nitrogenous fertilizers	L, E, 8, 11
1.1/10	N source, calcareous soils	Grass	Various nitrogenous fertilizers	E, 6, 7, 8
1.1/11	N source, acid soils	Grass	Various nitrogenous fertilizers	1, 3, 5
1.1/12	N time and method	Mustard	Time and method of broadcasting ammonium sulphate	E, 7, 8, 11
1.1/13	N time and method	Mustard	Time and method of application of ammonium sulphate	L, E
1.1/14	N source	Potato	Nitrogenous fertilizers for potatoes	L, 1, 5, 7
1.1/15	N rate and time	Barley	Time of application in relation to grain yield and quality	5, 9
1.1/16	Soil N uptake	Grass	The relationship between soil nitrogen and yield on all-grass swards	L, E, 1, 2, 3 5, 6, 7, 8, 9, 11
1.2/1	Basic slag, acid soils	Grass	Various types of basic slag	1, 5
1.2/2	P rate and time	Lucerne	Rate and time of application of phosphate to established Lucerne	E
1.2/3	P source, nitrophosphates	(a) Potato (b) Swede	Various proportions of water soluble phosphate	3, 9 L, 1, 3
1.2/4	P source, nitrophosphates	(a) Potato (b) Swede	Various proportions of water soluble phosphate in the season of application only	E, 5, 8, 9, 11 E, 5, 6, 8, 9, 11
1.2/5	P source, nitrophosphates	Spring wheat	To measure in 1960 the residual effects of nitrophosphates applied in 1959	W
1.2/6	P source, nitrophosphates	Various	Residual effects of nitrophosphate experiments conducted in 1958	E, 5, 9, 11

Code No.	Title	Crop	Subject under investigation	Locations
1.2/7	P source and time, calcareous soils	Grass	Sources of phosphate in relation to sward compos tion and yield	7, 11
1.2/8	P source and time, acid soils	Grass	Sources of phosphate in relation to sward composition and yield	3, 6, 9
1.2/9	P rate and method, crop development	Winter wheat	Phosphate rate and method of application	L
1.2/10	P rate, broadcast, crop development	Spring cereal	Crop development and final yield as influenced by phosphate application	E, 1, 3, 5, 6, 7, 8, 9, 11
1.2/11	P rate and method, crop development	Spring cereal	Crop development and final yield as influenced by phosphate and method of application	E, 1, 3, 5, 6, 7, 8, 9, 11
1.3/2	K rate and time	Lucerne	Rate and time of potash application to established lucerne	E
1.3/3	K rate and time	Lucerne	Rate and time of potash application to established lucerne	E
1.4/1	NP rate and P time	Grass	Time and rate of phosphate application in relation to nitrogen rate	2, 3, 11
1.5/1	NK rate and K time	Grass	Time and rate of potash application in relation to nitrogen rate	5
1.6/1	PK time	Winter wheat	Time of application of phosphate and potash	E, 7,
1.6/2	PK time, early bite	Grass	Time of phosphate and potash application for the production of early bite	8, 9, 11
1.7/1	NPK rate	Potato	Nitrogen, phosphate and potash rates in relation to yield, disease control, potato quality and soil analyses	E, 1, 2, 3, 5, 6, 7, 8, 9, 11
1.7/3	NPK rate	Spring wheat	Nitrogen, phosphate and potash rates in relation to yield and soil analysis	5
1.7/4	NPK rate	Grass	Nitrogen, phosphate and potash rates in relation to yield and sward composition	1, 3, 8
1.7/6	NPK and FYM rate	Red clover	Residual effects of experiment conducted in 1957	L
1.7/8	NPK rate	Oats	Residual effects of experiment conducted in 1957	W

Code No.	Title	Crop	Subject under investigation	Locations
2.2/1	Mg rate	Mangold	The value of applied magnesium for mangolds in Cumberland	3
2.2/6	NKMg rate and K time	Grass	Nitrogen, potash and magnesium rates and potash time of application in relation to the composition of spring grass	E
2.2/7	KMg rate	Potato	The effect on yield where magnesium responses might be expected	2
2.2/8	Fertilizer and Mg rate	Early potato	The optimum rate of fertilizer and the need for magnesium for early potatoes in Pembrokeshire	8
2.2/9	Mg rate	Rotation	The additive effect of magnesium applications throughout a rotation	1
2.5/1	Marginal land development	Grass	The effect of a variety of nutrients on productivity	1, 2, 3, 5, 8, 9
2.5/2	B source	Swede	The availability of boron from various sources when incorporated in a fertilizer	W, 1, 3
2.5/3	B rate	Lucerne	The use of boron on poor stands of lucerne	E, 11
2.5/4	Cu source	Spring wheat	Various copper sources as soil applications for the control of copper deficiency	E
2.5/5	Chelated Mn	Spring wheat	Chelated manganese for soils giving symptoms of manganese deficiency in crops	E
2.12/1	Granule size, 41	(a) Grass (b) Swede	Granule size in relation to crop response to phosphate	5 5, 6
2.12/2	Granule size, nitrophosphates	Various crops	The residual effects of experiments conducted in 1958	1, 3, 9
2.12/2	Granule size, nitrophosphates	Swede	Granule size in relation to crop response to nitrophosphates	2, 9
2.12/4	Fertilizer form and rate	Early potato	The effect of fertilizer form and rate on yield	3
2.13/1	Compound fertilizer placement	Spring cereal	Combine drilling high rates of fertilizer under a wide range of conditions	L, E, 1, 2, 3, 5, 6, 7, 9, 11
2.13/2	47 rate, placement	Winter wheat	Combine drilling high rates of potash in a 0 : 14 : 28 compound	L, E

Code No.	Title	Crop	Subject under investigation	Locations
2.13/3	N rate, source and method	Barley	Rate and source of nitrogen when combine drilled	L, E
2.13/4	K rate, source and method	Barley	Rate and source of potash when combine drilled	L, E
2.13/5	NK rate, placement	Barley	The additive effect of rate of nitrogen and potash when combine drilled	L, E
2.13/6	P time and method	Winter wheat	Time and method of application of phosphate	L
2.14/1	NPK exhaustion	Potato	Response to these nutrients after successive years of nitrogenous fertilization in rotations	L
3.2/1	P storage	Rotation	Availability of phosphate in a variety of important soil types following phosphate applications	L, W, E, 1, 3, 5, 6, 7, 8, 9, 11
3.2/2	P storage	Rotation	Availability of phosphate in two soil types following phosphate applications	2
3.7/1	NPK rate	Rotation	The place of phosphate and potash in obtaining maximum crop responses to nitrogen	L
4.2/1	Cumulative Mg top dressing	Grass	Long term effect of repetitive small applications of magnesium on the magnesium content of herbage	W, 1, 2, 8
4.4/1	Sulphur requirement	Rotation	The sulphur requirement of crops over a long period	L
4.14/1	PK exhaustion	Rotations	Rotations that will best produce phosphate and potash responsiveness	L
4.14/2	K exhaustion	Rotation	Residual effect of potash applied to the annual experimental area at Levington	L
4.19/1	Herbicides and insecticides	Rotation	Long term effects of herbicide and insecticide applications in a normal farm rotation	L
6.9/1	NPK rate	Russian Comfrey	Nutrient requirements of an unusual crop	L
7.2/1	Mg, hypomagnesaemia	Rotation	Magnesium applications to grass and other fodder crops over several years in relation to animal health	11
7.2/2	Mg, hypomagnesaemia	Grass	Magnesium applications to grassland in relation to animal health	L

Code No.	Title	Crop	Subject under investigation	Locations
8.7/1	NPK rate, take-all	Winter wheat	Host nutrition and the incidence of take-all	L
8.7/2	NK rate, blight	Potato	Nitrogen and potash nutrition in relation to the crop's susceptibility to blight	E, 1, 6, 9
8.7/3	NP rate, blight	Potato	Nitrogen and phosphate nutrition in relation to the crop's susceptibility to blight	L
8.7/4	Time of planting, blight	Potato	Time of planting and the incidence of blight	L
8.7/5	N rate and time, take-all	Winter wheat	Rate and time of application of nitrogen in relation to take-all in wheat	L
8.7/6	Urea and Blitane sprays, blight	Potato	Foliar urea sprays and the resistance of potatoes to blight	L, E, 5, 9
8.7/8	N rate, time and method, blight	Potato	Late nitrogen applications to the soil or as foliar sprays in relation to blight resistance	L, E
9.3/1	Wheat bulb fly control	Winter wheat	Aldrin and phosphate in relation to crop yield and incidence of attack	E, 1, 7
9.3/2	Wheat bulb fly control	Winter wheat	Various incorporated insecticides combine drilled	E, 1, 7
9.3/3	Wireworm control	Potato	Fertilizers plus insecticides in relation to wireworm control and tuber quality	W, 2, 5
9.3/4	Aldrin plus fertilizer, storage	Potato	The efficiency of aldrin plus fertilizer for wireworm control after storage	L
9.3/6	Aldrin plus fertilizer, placement	Potato	Various placement methods for fertilizer plus aldrin for wireworm control	L, E
10.4/1	Herbicide, fertilizer, weed control	Grass	Herbicide incorporated in fertilizer applied in spring 1958	E, 5, 7, 8, 11
10.4/2	Herbicide, fertilizer, weed control	Grass	Herbicide incorporated in fertilizer applied in autumn 1957 and spring 1958	E, 7, 8, 11
10.4/3	Herbicide, N top dressing, weed control	Spring wheat	Herbicide incorporated in fertilizer as a top dressing for weed control	E, 2, 3, 11
10.4/4	Herbicide, fertilizer, weed control	Grass	Herbicide incorporated in fertilizer for weed control in grassland	E, 5, 7, 8, 11
10.4/5	Herbicide, fertilizer, weed control	Grass	Herbicide incorporated in fertilizer for weed control in grassland	E, 1, 2, 3, 5, 6, 7, 8, 9, 11

Code No.	Title	Crop	Subject under investigation	Locations
10.4/6	Herbicide carrier, form and rate	Creeping Buttercup	Form and rate of an inert carrier for herbicide when used for weed control in grassland	E
10.4/7	Herbicide carrier, form and rate	Mustard	Form and rate of an inert carrier for herbicide when used for control of charlock in cereals	L
10.8/1	Tecane, fertilizer, wild oat control	Various root crops	Tecane incorporated in fertilizer for the control of wild oats	E, 2, 6, 7,
10.8/2	Tecane survey	Various	Tecane incorporated in fertilizer for wild oat control under a wide range of conditions	E, 1, 2, 3, 5, 6, 7, 9, 11
10.8/3	Tecane/Aldrin relationship	(a) Potato (b) Sugarbeet	The effect on crop health, vigour and yield	L L
10.8/4	Aldrin/Tecane relationship	(a) Potato (b) Sugarbeet	The effect on crop health, vigour and yield	L L
10.8/5	Herbicide, grass control	Lucerne	Herbicides for grass control in established lucerne	L
12.1/1	FYM, K rate and source, tuber quality	Potato	FYM and potash source in relation to tuber quality and yield	L
12.1/3	K rate and source, tuber quality	Potato	Potash source in relation to tuber quality and yield	E, 3, 9, 11
12.1/4	NPK rate, quality and yield	Potato	The interaction of these nutrients in relation to tuber quality and yield	2
16.1/1	Sampling technique	Kale	The optimum sampling procedure for estimating the yield of kale	L
16.5/1	Plot size	(a) Potato (b) Sugarbeet	Statistical examination of the results from various plot sizes	All
16.5/2	Plot size	Grass	Statistical examination of the results from two plot sizes	All
16.5/3	Plot size, Allen scythe technique	Cereals	Plot size in relation to the use of an Allen scythe for harvesting cereal plots	L
16.5/5	Plot size, combine harvester	Cereals	Plot size and type of combine for the harvesting of cereal plots	L
16.6/1	Harvesting technique	Cereals	Harvesting methods for cereal plots	L
16.7/1	Sampling technique	Soil	Variability of soil samples after various fertilizer placement methods	L

Horticultural Field and Pot Experiments

The 1959 horticultural programme consists of ninety-one experiments with 3,366 plots. The fruit experiments are concerned mainly with plant establishment and with nitrogen, phosphate and potash nutrition. In glasshouse investigations on tomatoes, cucumbers and carnations, the main interests are the effects of various sources of nitrogen, rates of application of nitrogen, phosphate and potash, and liquid fertilizers. Vegetable experiments study nutrition, persistent herbicides, insecticides and growth promoting and inhibiting substances. The turf programme covers sward production, nitrogen, phosphate and potash requirements of turf, and weed eradication.

Key to Locations

L	Levington
W	North Wyke
E	East Anglian counties
12	Western counties
13	Eastern counties
14	Southern counties

Code No.	Title	Crop	Subject under investigation	Locations
FRUIT				
F1.1/1	N source	Strawberry	Organic and inorganic sources of nitrogen	L
F1.4/1	NP source and Mg rate	Strawberry	Organic and inorganic sources of nitrogen and phosphate, and rate of applied magnesium	L
F1.4/2	NP source and Mg rate	Blackcurrant	Organic and inorganic sources of nitrogen and phosphate, and rate of applied magnesium and trace elements	L
F1.7/1	NPK rates and time of application	Strawberry	Fertilizer rates and time of application in relation to flowering, fruiting, disease incidence and tissue composition	L

Code No.	Title	Crop	Subject under investigation	Locations
F1.7/2	NPK rates and time of application	Blackcurrant	Fertilizer rates and time of application in relation to flowering, fruiting, disease incidence and tissue composition	L
F1.7/3	NPK rates and time of application (2)	Strawberry	Fertilizer rates and time of application in relation to flowering, fruiting, disease incidence and tissue composition	L
F2.9/1	Chelated iron and the correction of iron deficiency	Apple	Soil application of chelated iron	13
F2.9/2	Chelated iron and the correction of iron deficiency	Apple	Soil application of chelated iron	13
F2.9/3	Chelated iron and the correction of iron deficiency	Apple	Soil application of chelated iron	13
F2.14/1	Nutrient deficiencies	Blackcurrant	Deficiencies of nitrogen phosphate, potash, magnesium and trace elements	L
F2.14/2	Nutrient deficiencies	Culinary Apple	Deficiencies of nitrogen phosphate, potash, magnesium and trace elements	L
F2.14/3	Nutrient deficiencies	Dessert Apple	Deficiencies of nitrogen, phosphate, potash, magnesium and trace elements	L
F2.14/4	Nutrient deficiencies	Pear	Deficiencies of nitrogen, phosphate, potash, magnesium and trace elements	L
F5.5/1	Mulching and N requirement	Blackcurrant	Rates of application of nitrogen with and without straw mulch	L
F6.6/1	Establishment	Blackcurrant	Methods of establishment	L
F6.6/2	Establishment	Dessert Apple	Methods of establishment	L
F6.6/3	Establishment	Pear	Methods of establishment	L
F10.2/1	Herbicides	Blackcurrant	A persistent herbicide	L
F10.10/1	Runner inhibition	Strawberry	Chemical inhibition of runner production	L
F10.10/2	Runner inhibition	Strawberry	Chemical inhibition of runner production	L

Code No.	Title	Crop	Subject under investigation	Locations
GLASSHOUSE CROPS				
G1.1/1	N source	Tomato	Organic and inorganic sources of nitrogen	L
G1.1/2	N source	Cucumber	Organic and inorganic sources of nitrogen	L
G1.1/3	N source (2)	Tomato	Various organic sources of nitrogen	L
G1.5/1	NK rate and N source	Carnation	Nitrogen source and nitrogen and potash rates for top dressing	L
G1.7/1	NPK nutrition	Tomato	Nitrogen, phosphate and potash nutrition	L
G2.8/1	Liquid feeding	Tomato	Methods of using liquid fertilizers	L
G2.8/2	Liquid feeding	Carnation	Methods of using liquid fertilizers	L
G2.8/3	Ring culture	Tomato	Various methods of ring culture	L
G2.8/4	Liquid feeding	Tomato	Methods of using liquid fertilizers	L
G2.8/5	Liquid feeding	Pot plants	Methods of using liquid fertilizers	L
G2.9/1	Foliar chlorosis	(a) Hydrangea (b) Primula	Soil application of chelated iron for the correction of foliar chlorosis	L L
G2.23/1	Growth and flowering	Pot plants	The effect of a growth substance on growth and flowering	L
VEGETABLES, FLOWERS, ETC.				
V1.1/1	N rate, source and time	Anemone	Various nitrogen sources and rates and times of application	W
V1.7/1	NPK rate	Anemone	The nitrogen, phosphate and potash requirement of the anemone crop	W
V2.9/1	Foliar chlorosis	Rose	The correction of lime induced chlorosis	14
V2.23/1	Growth and flowering	Gladiolus	The effect of a growth substance on growth and flowering	L
V2.23/2	Growth and flowering	Dahlia	The effect of a growth substance on growth and flowering	L

Code No.	Title	Crop	Subject under investigation	Locations
V2.23/3	Growth and flowering	Pelargonium	The effect of a growth substance on growth and flowering	L
V2.23/4	Growth	Celery	The effect of a growth substance on growth	L
V2.23/5	Growth	Cabbage	The effect of a growth substance on growth	L
V6.11/1	Irrigation, spray distribution pattern	—	The water distribution pattern from the Levington irrigation system	L
V6.13/1	Cut flower longevity	Various	Flower preservatives	L
V9.7/1	Pest control	Various	A general purpose insecticide	L
V9.7/2	Pest control	Various	A general purpose insecticide	L
V9.7/3	Pest control	Various	A general purpose insecticide	L
V9.8/1	Pest and disease control	Various	The degree of pest and disease control from a combined insecticide and fungicide	L
V10.2/1	Perennial weed control	Weeds	Spot treatments with herbicides	L
V10.2/2	Perennial weed control	Weeds	A persistent weed killer	L
V10.2/3	Weed control	—	A persistent weed killer	E
V10.2/4	Phytotoxicity	Shrubs	Shrubs in relation to the use of a persistent weed killer	E
V10.2/5	Phytotoxicity	Hedges	Hedges in relation to the use of a persistent weed killer	E
V10.2/6	Moss Eradication	—	A persistent weed killer for moss control	E
V10.2/7	Selective weed control	Asparagus	A persistent weed killer for the control of weeds in asparagus	E
V10.10/1	Growth inhibitor	(a) Privet (b) Hawthorn	Phytotoxic effects of a growth inhibitor	E L

Code No.	Title	Crop	Subject under investigation	Locations
V10.10/2	Growth inhibitor	Privet	Concentration and method of application of a growth inhibitor	E
V10.10/4	Growth inhibitor	(a) Privet (b) Hawthorn	Frequency and time of application of a growth inhibitor	E L
V10.10/5	Growth inhibitor	(a) Privet (b) Hawthorn	Rate of application of a growth inhibitor	E L

FINE TURF

T1.1/1	N source	Turf	Various organic and inorganic sources of nitrogen	E
T1.1/2	N source establishment	Turf	Organic and inorganic sources of nitrogen for turf establishment	L
T1.1/3	N source and rate	Turf	Nitrogen source and rate over a long period	L
T1.4/1	P rate and source	Turf	Rates and sources of phosphate	L
T1.6/1	PK rate and time	Turf	Rate and time of application of phosphate and potash in relation to growth, botanical composition and incidence of disease	L
T1.7/1	NPK rate	Turf	Nitrogen, phosphate and potash rates in relation to growth, botanical composition and incidence of disease	L
T1.7/2	NPK rate	Turf	Nitrogen, phosphate and potash rates and persistence of annual meadow grass	L
T2.8/1	Liquid feeding	Turf	Methods of using liquid fertilizers	L
T2.8/2	Liquid feeding	Turf	Comparison of liquid and powder fertilizers	L
T10.1/1	Copperas in lawn fertilizer	Turf	Copperas and turf colour	L
T10.2/1	Herbicides	Turf	Time of application of herbicides	L

Above: The analytical laboratory of the Chemistry Department, Levington, exemplifies the general structural design and facilities.

Below: The Pot Trials Unit glasshouses are designed for maximum light and efficient temperature control. In this instance movable benches support the pots which are set in moistened sand to supply water to the plants by upward absorption.

Above: At Levington there are 123 agricultural and horticultural field experiments containing over 5,000 plots which are managed by Field Experimental Officers and Recorders. Determination of yields and representative sampling of herbage from plots are illustrated.

Below: Detailed investigations are important. In situ pH determination is illustrated.

Below: Radioactive phosphorus is one of the main tools in soil research and must be handled in a protective 'glove box'.

Code No.	Title	Crop	Subject under investigation	Locations
T10.2/2	Herbicides	Turf	Pre-sowing application of selective herbicides in relation to grass seed germination	L, W
T10.2/3	Herbicides	Turf	Herbicides and weed control	L
T10.2/4	Herbicides	Lettuce	The effect of grass mowings from turf treated with selective herbicides when used as a mulch after composting	L
T10.2/5	Herbicides	Turf	Selective herbicides on turf containing clover	L
T10.2/6	Herbicides	Turf	The control of pearlwort by various selective weedkillers	E
T10.2/8	Herbicides	Turf	Selective herbicides on turf containing clover	L
T10.2/9	Herbicides	Turf	Concentration of selective herbicides when used on fine turf	E
T10.4/1	Herbicides	Turf	Methods of application of selective herbicides to fine turf	E
T10.4/2	Herbicides	Turf	Methods of application of selective herbicides to fine turf	E
T10.7/2	Moss eradication	Turf	Chemicals for moss control	E
T10.7/3	Moss eradication	Turf	A chemical for moss control	E
T10.7/5	Moss eradication	Turf	Chemicals for moss control	E
T10.7/6	Moss eradication	Turf	Chemicals for moss control	E
T10.9/2	Herbicides	Turf	Methyl sec-butyl urea and establishment of fine turf	L
T10.10/1	Growth inhibitors	Turf	Growth inhibition of fine turf	L
T10.10/2	Growth inhibitors	Turf	Growth inhibition of fine turf	L
T10.10/3	Growth inhibitors	Turf	Growth inhibition of fine turf	L
T10.11/1	Moss eradication	Turf	Chemicals for moss control	E
T10.11/2	Moss eradication	Turf	A chemical for the control of moss	E

Pot Experiments

The Pot Trials Unit programme for 1959 consists largely of the main subjects investigated in 1958 to consolidate the findings and enlarge the field of investigation. Included in the programme are (a) the evaluation of a number of phosphates with different proportions of water-soluble and water-insoluble phosphate, (b) a comparison of the agronomic value of several rock phosphates, (c) the comparative usefulness of ammoniated superphosphate and superphosphate, (d) the long term availability of nitrogen from ureaformaldehydes and organic nitrogen sources, (e) metal chelates for correcting soil deficiencies, (f) particle size of slag, (g) environmental factors which may influence the control of wild oats obtained by Tecane incorporated in fertilizer.

In addition, accommodation in the cage and glasshouses will be provided for pot experiments in connection with the work of all fundamental research sections.

Code No.	Title	Crop	Subject under investigation
Agronomic Projects			
P1.1/1	N nutrition (residual)	Mustard	The residual availability of nitrogen from various organic sources – short term effect
P1.1/2	N nutrition (residual)	Ryegrass	The residual availability of nitrogen from various organic sources – long term effects
P1.2/1	P nutrition	Oats	Various mineral phosphates
P1.2/2	P nutrition	Barley	Various water-soluble and water-insoluble phosphates
P1.2/3	P nutrition	Mustard	The residual value of the phosphates examined in P1.2/2
P1.2/4	P nutrition	Barley	The agronomic value of varying water-soluble/water-insoluble phosphate ratios
P1.2/9	P nutrition	Barley	Ammoniated superphosphates
P1.7/1	NPK nutrition	Mustard	The correlation of crop responses and soil analyses.
P2.5/1	Boron nutrition	Broad bean Red clover	The availability of Boron in various sources incorporated in fertilizer

Code No.	Title	Crop	Subject under investigation
P2.9/1	Iron nutrition	Maize	Iron deficiency control by various iron sources
P2.12/1	Particle size, basic slag	Ryegrass	Basic slag ground to various particle sizes
P2.16/1	N nutrition	Ryegrass	The long term release of nitrogen from ureaformaldehydes
P2.19/4	Biuret toxicity	Mustard	The occurrence of toxicity from biuret and cyanate
P10.8/1	Weed control	Wild oat	Environmental factors in relation to the effectiveness of Tecane incorporated in compound fertilizer for wild oat control
Basic Research Projects			
P53.2/1	L-value; indicator crop	Various	The influence of indicator crop on L-value
P53.2/2	L-value; initial soil moisture status	Ryegrass	The influence on L-value of soil moisture status prior to potting
P53.2/3	L-value; moisture supply during growth	Ryegrass	The influence of sub-irrigation on utilization of labile soil phosphorus
P53.4/1	Root decomposition	Ryegrass	The effect of decaying plant material on the soil-phosphate status
P53.5/1	L-value; liming	Ryegrass	The effect of liming on L-value
P53.13/1	P-Utilization; N source and method (1)	Barley	Placement of different nitrogen sources in relation to fertilizer phosphorus utilization
P53.13/2	P-utilization; N source and method (2)	Barley	Placement of different nitrogen sources in relation to the utilization of two phosphate fertilizers
P53.13/3	L-value; N source and rate	Ryegrass	L-value of soil as influenced by different sources and rates of nitrogen
P101.3/1	P nutrition	Pea	The fate of luxury amounts of phosphate in the plant
P110.2/12	Technique	Pea	Production of plant material containing P^{32}
P113.1/7	P^{32} and P absorption (2)	Ryegrass	The influence of P^{32} level on phosphorus absorption by plants
P113.2/3	L-value; phosphate equilibration	Ryegrass	Pre-equilibration of P^{32} with soil as a means of reducing the duration of L-value experiments
P113.2/4	L-value; radioactive P source	Ryegrass	Different sources of labelled phosphate for use in L-value experiments
P113.2/5	L-value; P rate	Ryegrass	Effect of rate of labelled phosphate on L-value

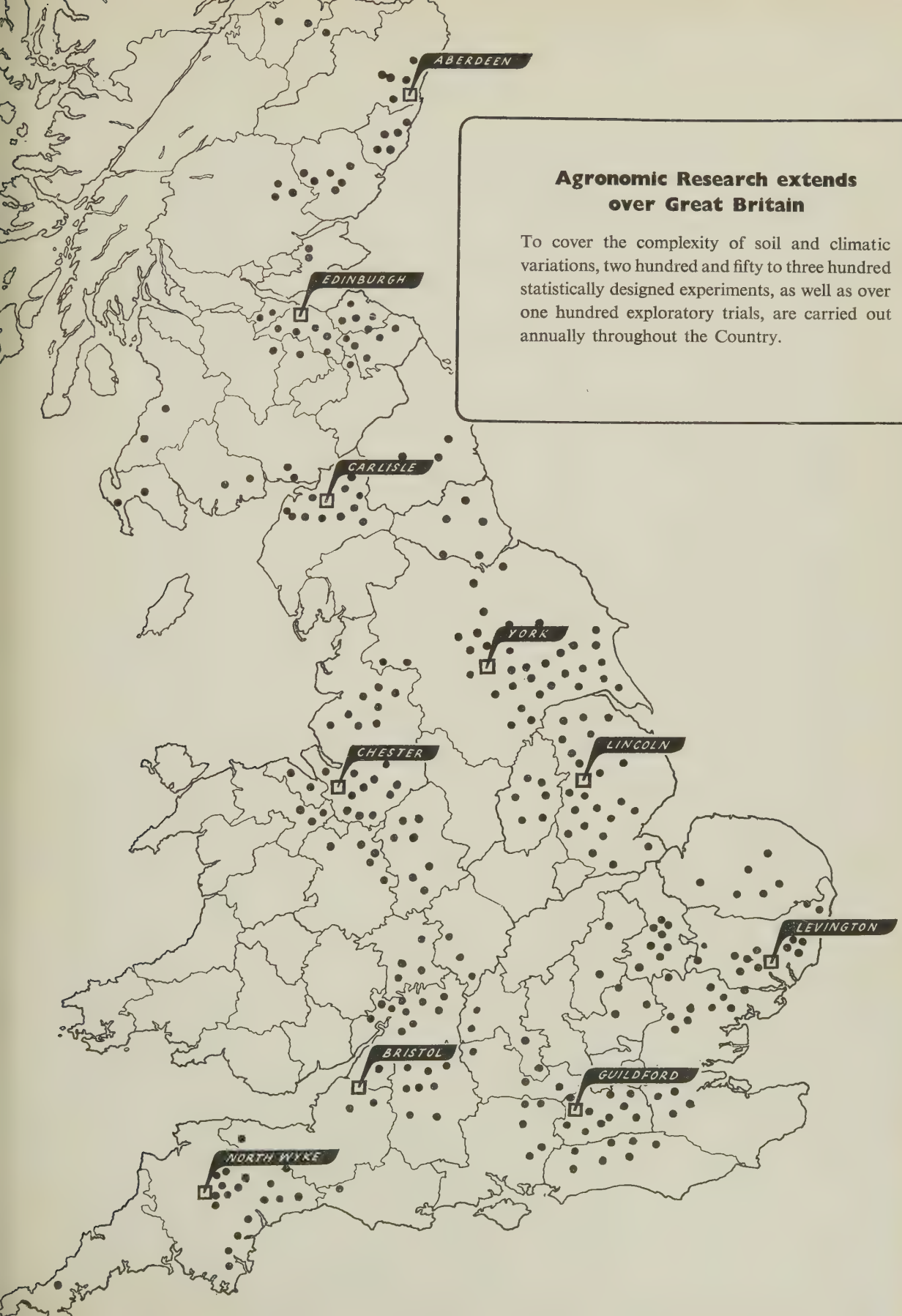
The field experiments in the provinces are designed and initiated at Levington Research Station and supervised by the following Agricultural Advisers, each responsible for one of the locations into which the Country is divided.

Location			
1	Aberdeen	J. M. Coull, Fisons Limited, The Ice Rink, South Anderson Drive, Aberdeen.	*Aberdeen 33323*
2	Edinburgh	H. P. Henderson, Fisons Limited, 49 North Castle Street, Edinburgh.	*Edinburgh 34344*
3	Carlisle	W. K. Letheren, The Poplars, Houghton, Carlisle, Cumberland.	*Carlisle 23155*
5	Chester	I. R. English, Field House, Okell's Lane, Cuddington, Northwich, Cheshire.	*Sandiway 2162*
6	York	W. A. G. Mason, Fisons Limited, Harvest House, York.	*York 45475*
7	Lincoln	F. W. Dunnett, Fisons Limited, Harvest House, Carholme Road, Lincoln.	*Lincoln 11112*
8	Bristol	J. D. Edward, Fisons Limited, 11-19 Wine Street, Bristol.	*Bristol 27191/4*
9	North Wyke	P. G. Shaw, Downside, Whitchurch, Tavistock, Devon.	*Tavistock 3161*
11	Guildford	K. C. Morrison, Hillside, Lynwick Street, Rudgwick, Sussex.	*Rudgwick 268*
E	Levington	A. M. Ainsley, Levington Research Station, Levington, Ipswich, Suffolk.	*Ipswich 76911*

The Levington Horticultural Advisers located in the provinces are:

Western Counties	C. P. Quarrell, 37 Northwick Close, Worcester.	*Foregate 634*
Southern Counties	J. C. Bush, 1a Hyde Abbey Flats, Hyde Street, Winchester.	*Winchester 3171*

Other areas are served from Levington Research Station.



Agronomic Research extends over Great Britain

To cover the complexity of soil and climatic variations, two hundred and fifty to three hundred statistically designed experiments, as well as over one hundred exploratory trials, are carried out annually throughout the Country.

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